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# Effect of Physician Specialty on Use of Necessary Coronary Angiography

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***Objectives.*** **This study sought to determine whether having a cardiologist as a regular source of care influences likelihood of undergoing necessary coronary angiography.**

***Background.*** **An important element of the current health policy debate is the respective roles of primary care and specialist physicians. However, there are few data on interspecialty differences in quality of care for patients with ischemic heart disease.**

***Methods.*** **We contacted 243 patients by telephone (response rate 72%) who had positive (or very positive) exercise stress test results and met additional clinical criteria for necessary coronary angiography. Study patients were randomly sampled from those undergoing exercise stress testing at one university and three public hospitals in Los Angeles between January 1, 1990 and June 30, 1991. Patients were asked whether they had a regular source of care during the time after their exercise stress test and, if so, whether that provider was a cardiologist or cardiology clinic.**

***Results.*** **Among survey responders, 47% underwent necessary coronary angiography within 3 months of exercise testing and 61% within 12 months. After adjustment for sociodemographics and clinical presentation, patients with a cardiologist as a regular source of care were more likely than all other patients to have undergone necessary angiography within 3 months (52% vs. 38%, $p = 0.05$) and within 12 months (74% vs. 44%, $p = 0.0001$) of the exercise test. At 3 months, there was a trend toward a more pronounced effect of ongoing cardiologic care within the public hospitals compared with the private hospital ($p = 0.09$ for interaction between hospital types).**

***Conclusions.*** **Patients with a cardiologist as a regular source of care were more likely than all other patients to undergo clinically necessary coronary angiography within both 3 and 12 months of exercise stress testing.**

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Coronary angiography is the critical diagnostic test leading to revascularization procedures for ischemic heart disease. Previous studies of variations in the use of this procedure have examined the effects of readily available patient variables, such as ethnicity (1–5), insurance status (6,7) and gender (8). Although the methods used in these studies could not determine whether differences in use represented overuse or underuse, these studies have generally shown that African-Americans, women and the uninsured undergo fewer cardiac procedures than their male, insured and non-African-American counterparts.

Little is known about the effect of other patient, physician and health care system characteristics on variations in the use of invasive cardiac procedures. The Expanded Health Behavior Model (9) provides a broad framework that includes characteristics of the health delivery system and of the population at risk. We used this model to study the failure to obtain necessary coronary angiography. Because of its policy relevance, we emphasize one variable: the specialty of the "regular source of medical care." In the case of patients with confirmed or suspected coronary artery disease, a "regular source of care" can be a generalist primary care provider (such as a family physician or general internist) or a specialist (such as a cardiologist).

The respective roles of primary care and specialist physicians are currently under scrutiny in many health delivery systems. Some investigators (10) have pointed out that undertreatment may result if primary care physicians are inadequately prepared for the task of gatekeeping. Failure to receive a medically necessary procedure is one potential example of such undertreatment.

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**Table 1.** Examples of Necessary Indications and Their Panel Ratings

| Indication | Median Rating |
|---|---|
| Unstable angina within 3 mo before EST, now with CCS angina class III–IV/IV treated with maximal medical therapy*; pt <75 years old | 9 |
| Chronic stable CCS angina (class III–IV/IV) treated with maximal medical therapy*; very positive exercise stress test results, positive stress imaging study results†; pt <75 years old | 9 |
| Chronic stable angina (CCS class I–II/IV) treated with maximal medical therapy*; positive EST results; positive stress imaging study results†; normal ejection fraction; pt <75 years old | 8 |
| Atypical chest pain; very positive EST results; no stress imaging study; ≤1 CAD risk factor‡; pt <75 years old (men) or 50–75 years old (women) | 7 |
| Asymptomatic; very positive EST results; positive stress imaging results; ≤2 CAD risk factors‡; pt <75 years old | 7 |

*Two or more types of antianginal medications. †Thallium scintigraphy or echocardiography. ‡Smoking, hypertension, diabetes, hypercholesterolemia and family history of coronary artery disease (CAD). CCS = Canadian Cardiovascular Society; EST = exercise stress test; pt = patient.

Although interspecialty differences in resource use are generally cited as evidence of overtreatment, they could also suggest undertreatment. Recent studies have shown that cardiologists use office-based resources more intensely than generalists (11) and that geographic regions with more specialists have higher payments per Medicare beneficiary (12). Studies have also demonstrated better outcomes for diabetic patients who are managed in specialized clinics (13) and by physicians with a particular interest in diabetes (14). A single recent survey (15) demonstrated that generalists are less knowledgeable about advances in the treatment of myocardial infarction than are cardiologists. Otherwise, however, data on interspecialty differences in quality of care for patients with ischemic heart disease are lacking. Whether particular systems of care modify interspecialty differences is also not known but is of obvious importance in this changing health care environment. The current study addresses this critical issue by examining specialty differences in the use of clinically necessary coronary angiography.

## Methods

The present study was reviewed and approved by the University of California Los Angeles Human Subjects Committee, on June 18, 1991.

**Patients.** The patient cohort was selected using clinical criteria for "necessity of coronary angiography" as formulated by a nine-member RAND/UCLA expert panel composed of primary care physicians, noninvasive and invasive cardiologists and cardiothoracic surgeons (16,17). The panelists rated 840 separate clinical indications (sets of explicit clinical characteristics) on a 1- to 9-point scale, where 1 = definitely not necessary, and 9 = definitely necessary. After discussion and rerating using a modified Delphi process, there were 390 indications rated necessary (median rating of 7 to 9). The panel used the following definition of "necessity":

> The necessity of coronary angiography implies that the physician is obliged to recommend the procedure as an option to the patient presenting with certain indications because of the belief that the procedure is clearly the best option available to the patient.

Examples of indications are shown in Table 1. The indications include information on various patient characteristics, including age, symptoms, medications and diagnostic test results.

The sample was identified through a multistage process, starting with a review of 5,850 randomly selected exercise stress tests at four Los Angeles hospitals; results of 1,350 of these stress tests were classified as positive or very positive, and the medical records of these subjects were abstracted for additional clinical data. A *positive* stress test result was defined as ≥1-mm horizontal or downsloping ST segment depression or typical angina after the first 3 min of exercise. *Very positive* was defined as ≥1-mm horizontal or downsloping ST segment depression or typical angina during the first 3 min of exercise or ≥2-mm ST segment depression at any time. In addition, persistence of ST segment depression >6 min after exercise was considered very positive. The stress test results and clinical data were then evaluated in combination to determine whether a patient met one of the 390 indications for necessary coronary angiography. (Additional details on sampling for this study are found in M. Laouri et al. unpublished data, available on request). Three hundred fifty-two patients were found to meet necessary indications, of whom 243 were reached for a telephone survey (72% of living patients).

**Survey.** To determine whether patients underwent coronary angiography and to understand why it may not have been performed, we conducted a telephone survey of patients who met indications for necessary coronary angiography. The survey included questions about whether coronary angiography was performed or recommended, perceptions of why coronary angiography was not performed, sociodemographic information, whether the patient had a regular source of care and the specialty of the regular source of care. Items were pilot tested with patients from two study hospitals to improve clarity. The survey was administered in English or Spanish by trained interviewers. We used the following sources of information as needed to contact patients by telephone: patient telephone numbers listed in the medical record, emergency contact numbers, local directory assistance and hospital patient identification data bases. Respondents received $5 for completion of the survey. Los Angeles county death records were searched for all nonrespondents.

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**Key measures.** Patients were considered to have obtained needed care if they underwent angiography within 3 months of the index exercise treadmill test as recorded in the medical record or if they reported in the telephone survey that they had undergone coronary angiography within 3 months of the exercise treadmill test. To allow some leeway in the timing of the procedure, we also examined whether patients had undergone angiography within 12 months of the index treadmill test. The specialty of the patients' regular source of care near the time of exercise treadmill testing was determined by a sequence of survey questions. Patients were first asked whether they had a regular source of care:

> Please think back to the time you had the treadmill test on [date of treadmill]. During the months after that test, did you have one person or place in particular you usually went to when you were sick or wanted advice about your health?

Patients with a regular source of care were then asked whether the major specialty of their doctor was best described by "family practice, internal medicine, cardiology, or some other specialty."

**Data analysis.** Chi-square, Student *t* and Wilcoxon two-sample tests were used to examine relationships between predictor variables and receipt of coronary angiography within 3 and 12 months of treadmill testing. Variables related to the outcome ($p < 0.1$) in bivariate analysis or that were considered clinically important were included in multiple logistic regression analyses to determine their independent contributions to performance of coronary angiography. We calculated 95% confidence intervals for adjusted odds ratios. We also calculated predicted probabilities for performance of coronary angiography in patients with and without a cardiologist as a regular source of care by using the final logistic regression models and holding other variables at their sample mean values.

We performed additional analyses, which included in the logistic models an interaction term for hospital type (university vs. public) and specialty of regular source of care. Further, to assess the accuracy of the telephone survey, we obtained a complementary measure of specialty of regular source of care (whether a cardiologist had ordered the exercise stress test) for a subset of patients ($n = 109$) at two study hospitals who reported having a regular source of care. For these patients, the total agreement between patient-reported cardiologist regular source of care and whether a cardiologist ordered the treadmill test was 69%. Agreement between the two methods beyond chance was fair (kappa 0.37) (18). We then performed multiple logistic regression using performance of angiography as the outcome and substituted the complementary measure (whether a cardiologist ordered the exercise stress test) for the survey measure of regular source of care specialty while controlling for age, gender, race, hospital and clinical category.

## Results

**Characteristics of sample.** Among 352 enrollees, 12 died before the follow-up started, and 1 could not be interviewed because he was deaf. Of the remaining 339 patients, 243 (72%) completed the survey. Hispanics, patients who obtained their exercise stress test at a public hospital and patients with more severe diagnoses, such as unstable angina or recent myocardial infarction, were somewhat underrepresented in the response group (Table 2). The mean age of nonresponders (57 years) was slightly less than that of responders (59 years) ($p < 0.05$).

**Characteristics of patients undergoing coronary angiography: bivariate analysis.** Overall, 43% of all study patients and 47% of survey responders underwent necessary coronary angiography within 3 months of exercise treadmill testing. Within 12 months of treadmill testing, 61% underwent the procedure. On bivariate analysis of patients undergoing angiography within 3 months of treadmill testing, 4 of 14 variables studied were significant at the $p < 0.05$ level (Table 3). Men were more likely than women to undergo angiography, as were patients who had more severe clinical diagnoses, such as unstable angina and myocardial infarction, compared with asymptomatic patients. Patients with clinical indications assigned a panel rating of 9 (as opposed to 7 or 8) were more likely to undergo angiography, and patients who stated that their regular source of care during the months after the exercise treadmill test was a cardiologist or cardiology clinic were more likely to undergo angiography than all other patients. Patients with no regular source of care ($n = 30$), who may have had their stress test ordered by an emergency room physician, underwent angiography at a rate similar to patients with a regular source of care other than cardiology ($n = 75$) (40% vs. 39%, data not shown in tabular form). For this reason, these two patient groups were combined in subsequent analyses ($n = 105$).

Patients undergoing angiography within 12 months of treadmill testing did not differ significantly by gender or by panel rating ($p > 0.05$). However, differences by clinical diagnoses and specialty of regular source of care were larger than at 3 months after treadmill testing (Table 3). Twelve-month angiography rates among patients with a noncardiologist as a regular source of care and those with no regular source of care were comparable (45% and 43%, respectively).

**Characteristics of patients with and without a cardiologist as a regular source of care: bivariate analysis.** Because having a cardiologist as a regular source of care was associated with obtaining necessary angiography, we examined patient factors that might be related to having a cardiologist. Patients with a recent myocardial infarction or unstable angina had a cardiologist as a regular source of care more often than asymptomatic patients (Table 4). The proportion of patients with a cardiologist as a regular source of care who had atypical chest pain, chronic stable angina or chest pain after coronary artery bypass grafting was similar to that for asymptomatic patients. A very positive exercise stress test result (compared with positive test result) was not associated with having a cardiologist as a regular source of care. Public hospital patients were more

**Table 2.** Sociodemographic and Clinical Characteristics of Sample*

| Characteristic | Total (n = 352) | Survey Respondents (n = 243) | Survey Nonrespondents (n = 109) | 95% CI Difference (%) |
|---|---|---|---|---|
| Gender (% male) | 59.9 | 59.7 | 60.6 | (−10, 12) |
| Ethnicity/race (%) | | | | |
| White | 42.1 | 44.9 | 35.8 | (−2, 20) |
| African-American | 18.8 | 21.4 | 12.8 | (0.4, 17) |
| Latino | 28.4 | 21.8 | 43.1 | (11, 32) |
| Asian/other | 10.8 | 11.9 | 8.3 | (−3, 10) |
| Public hospital (%) | 63.9 | 54.3 | 85.3 | (22, 40) |
| Clinical category (%) | | | | |
| Asymptomatic | 16.8 | 18.9 | 11.9 | (−0.8, 15) |
| Atypical chest pain | 19.3 | 21.0 | 15.6 | (−3, 14) |
| Chronic stable angina | | | | |
| CCS class I–II/IV | 21.0 | 23.1 | 16.5 | (−2, 15) |
| CCS class III–IV/IV | 16.8 | 16.1 | 18.4 | (−6, 11) |
| Unstable angina | 16.8 | 13.6 | 23.9 | (1, 19) |
| MI (prior 12 wk) | 5.7 | 4.1 | 9.2 | (−0.9, 11) |
| Prior CABG with recurrent chest pain | 3.7 | 3.3 | 4.6 | (−3, 6) |

*Percentages may not add to 100 because of rounding. Respondents are those whose telephone survey was completed. CABG = coronary artery bypass graft surgery; CCS = Canadian Cardiovascular Society; CI = confidence interval; MI = myocardial infarction.

likely than university hospital patients to have a cardiologist as a regular source of care (63% vs. 49%). Age, gender and ethnicity/race were not associated with having a cardiologist as a regular source of care.

**Effect of having a cardiologist as a regular source of care on likelihood of undergoing coronary angiography: multivariate analysis.** After controlling for age, gender, race, hospital system (university vs. public hospital), number of cardiac risk factors, symptom severity and number of years at home address, patients whose regular source of care was a cardiologist had increased odds of undergoing necessary angiography within 3 months compared with all other patients (odds ratio [OR] 1.8, 95% confidence interval [CI] 0.99 to 3.1) (Table 5). The relative odds of undergoing angiography within 12 months of treadmill testing for patients with a cardiologist as a regular source of care were more sharply increased higher (OR 3.6, 95% CI 2.0 to 6.6). After controlling for patient age, gender, race, hospital and symptom severity for a subgroup of 109 patients, those whose treadmill test had been ordered by a cardiologist also had increased odds of undergoing necessary angiography within 12 months (OR 3.0 95% CI 1.1 to 8.1).

After substitution of mean values for the covariates included in our model, the adjusted probability of patients of cardiologists undergoing clinically necessary coronary angiography within 3 months was 0.52 compared with 0.38 for patients with a noncardiology or no regular source of care ($p = 0.05$). For angiography within 12 months of treadmill testing, the adjusted probability of patients of cardiologists undergoing the procedure was 0.74 compared with 0.44 for patients with a noncardiologist or no regular source of care ($p < 0.0001$).

The interaction term between hospital type (university vs. public) and regular source of care specialty approached statistical significance for patients undergoing angiography within 3 months ($p = 0.09$) and 12 months ($p = 0.13$) of treadmill testing. Because of the suggestion that the effect of having a cardiology regular source of care differs across hospital settings, we reestimated our logistic model, first for the university and then for the public hospitals. For undergoing the procedure within 3 months of treadmill testing, the adjusted odds ratio for university patients with a cardiologist as a regular source of care compared with all other university patients was 1.1 (95% CI 0.5 to 2.5). However, the adjusted odds ratio for public hospital patients with a cardiologist as a regular source of care compared with all other public hospital patients was 3.2 (95% CI 1.3 to 7.8). The adjusted odds ratio for patients undergoing angiography within 12 months for university patients with a cardiologist as a regular source of care was 2.6 (95% CI 1.1 to 6.4), and that for public hospital patients with a cardiologist as a regular source of care was 6.7 (95% CI 2.7 to 16.8).

**Patient adherence to recommended care.** Using information from the medical record and survey, we found that of 243 patients, 8 were advised to undergo coronary angiography but refused the procedure, 3 sought alternative care, 3 patients missed appointments for antecedent procedures or consultations, and 1 refused hospital admission. Thus, nonadherence was a problem for 15 patients (6.2% of all survey respondents, 15.8% of survey respondents who did not undergo necessary angiography). After exclusion of these patients from the logistic regression models, the odds of undergoing angiography for those with a cardiologist as a regular source of care versus those with a noncardiologist or no regular source changed only slightly (within 3 months OR 1.6, 95% CI 0.9 to 3.0; within 12 months OR 3.5, 95% CI 1.9 to 6.5).

**Table 3.** Characteristics Associated With Coronary Angiography Performed Within 3 and 12 Months of Exercise Stress Testing for 243 Patients*

| Characteristic | Angiography Within 3 mo [% (no.) of pts] | 95% CI Difference (highest − lowest) | Angiography Within 12 mo [% (no.) of pts] | 95% CI Difference (highest − lowest) |
|---|---|---|---|---|
| Age (yr) | | | | |
| ≥65 | 48.6 (34/70) | | 58.6 (41/70) | |
| 50–64 | 48.9 (69/141) | | 63.1 (89/141) | |
| ≤49 | 31.3 (10/32) | (−0.3, 36) | 56.3 (18/32) | (−12, 26) |
| Gender | | | | |
| Male | 52.4 (76/145) | | 65.5 (95/145) | |
| Female | 37.8 (37/98) | (2, 27) | 54.1 (53/98) | (−1, 24) |
| Ethnicity/race | | | | |
| White | 48.6 (53/109) | | 58.7 (64/109) | |
| African-American | 40.4 (21/52) | | 59.6 (31/52) | |
| Latino | 49.1 (26/53) | | 71.7 (38/53) | |
| Asian/other | 44.8 (13/29) | (−10, 28) | 51.7 (15/29) | (−2, 42) |
| Income | | | | |
| ≤$15,000 | 40.2 (35/87) | | 57.5 (50/87) | |
| $15,001–50,000 | 52.3 (23/44) | | 61.4 (27/44) | |
| >$50,000 | 57.1 (20/35) | (−3, 36) | 62.9 (22/35) | (−14, 25) |
| Education | | | | |
| >12 yr | 48.5 (47/97) | | 57.7 (56/97) | |
| ≤12 yr | 45.7 (64/140) | (−10, 16) | 63.6 (89/140) | (−7, 19) |
| Employment at time of EST | | | | |
| Full time | 53.0 (35/66) | | 62.1 (41/66) | |
| Other | 43.7 (76/174) | (−5, 24) | 60.3 (105/174) | (−12, 16) |
| No. of people in household | | | | |
| >1 | 47.9 (90/188) | | 62.2 (117/188) | |
| 1 | 41.8 (23/55) | (−9, 21) | 56.4 (31/55) | (−9, 21) |
| At current address | | | | |
| <2 yr | 33.3 (11/33) | | 60.6 (20/33) | |
| ≥2 yr | 48.0 (99/206) | (−3, 32) | 60.7 (125/206) | (−18, 18) |
| Travel time to hospital | | | | |
| <30 min | 46.6 (48/103) | | 57.3 (59/103) | |
| ≥30 min | 46.3 (62/134) | (−13, 13) | 64.2 (86/134) | (−6, 19) |
| Hospital | | | | |
| University | 53.2 (59/111) | | 61.3 (68/111) | |
| Public | 40.9 (54/132) | (−0.3, 25) | 60.6 (80/132) | (−12, 13) |
| Clinical category | | | | |
| Asymptomatic | 36.9 (17/46) | | 43.5 (20/46) | |
| Nonacute chest pain: angina or atypical chest pain | 43.2 (63/146) | | 60.9 (89/146) | |
| Unstable angina, MI or prior CABG with chest pain | 64.7 (33/51) | (9, 47) | 76.5 (39/51) | (15, 52) |
| Panel rating | | | | |
| 9 with agreement | 62.8 (27/43) | | 72.1 (31/43) | |
| Other | 43.0 (86/200) | (4, 36) | 58.5 (117/200) | (−1, 29) |
| Risk factor count | | | | |
| ≥2 | 47.9 (71/148) | | 64.2 (95/148) | |
| <2 | 44.2 (42/95) | (−9, 17) | 55.8 (53/95) | (−4, 21) |
| Regular source of care | | | | |
| Noncardiology or none | 39.0 (41/105) | | 44.8 (47/105) | |
| Cardiology | 52.2 (71/136) | (0.6, 26) | 73.5 (100/136) | (17, 41) |

*Varies for individual variables because of missing values. Abbreviations as in Tables 1 and 2.

## Discussion

In the present study, we found that the specialty of a patient's "regular source of care" is related to whether the patient undergoes clinically necessary coronary angiography. Patients of cardiologists were more likely to obtain the needed care. This effect was larger at 12 months than at 3 months after treadmill testing. There was a trend toward a greater effect in the public hospitals. Nonadherence by patients to physician recommendations played a relatively minor role in underuse of clinically necessary coronary angiography.

**Underuse of coronary angiography.** Underuse of coronary angiography occurs when a complex chain of events is not

**Table 4.** Characteristics Associated With Having a Cardiologist as a Regular Source of Care for 241 Patients*

| Characteristic | Cardiology Regular Source of Care [% (no.) of pts] | Difference (highest − lowest) | 95% CI Difference (highest − lowest) |
|---|---|---|---|
| Age (yr) | | | |
| ≥65 | 54.4 (37/68) | | |
| 50–64 | 56.7 (80/141) | | |
| ≤49 | 59.4 (19/32) | 5.0 | (−16, 26) |
| Gender | | | |
| Male | 57.3 (82/143) | | |
| Female | 55.1 (54/98) | 2.2 | (−10, 15) |
| Ethnicity/race | | | |
| White | 53.7 (58/108) | | |
| African-American | 59.6 (31/52) | | |
| Latino | 58.5 (31/53) | | |
| Asian/other | 57.1 (16/28) | 5.9 | (−10, 22) |
| Hospital | | | |
| University | 48.6 (53/109) | | |
| Public | 62.9 (83/132) | 14.3 | (2, 27) |
| Clinical category | | | |
| Asymptomatic | 45.7 (21/46) | | |
| Atypical chest pain | 60.0 (30/50) | | |
| Chronic stable angina | | | |
| CCS class I–II/IV | 47.3 (26/55) | | |
| CCS class III–IV/IV | 56.4 (22/39) | | |
| Unstable angina | 69.7 (23/33) | | |
| MI (prior 12 wk) | 90.0 (9/10) | | |
| Prior CABG with recurrent chest pain | 62.5 (5/8) | 44.3 | (21, 68) |
| EST results | | | |
| Very positive | 52.6 (71/135) | | |
| Positive | 61.3 (65/106) | 8.7 | (−4, 21) |
| Panel rating | | | |
| 9 with agreement | 60.5 (26/43) | | |
| Other | 55.6 (110/198) | 4.9 | (−11, 21) |
| Risk factor count | | | |
| ≥2 | 57.1 (84/147) | | |
| <2 | 55.3 (52/94) | 1.8 | (−11, 15) |

*Two missing values for regular source of care specialty. Abbreviations as in Tables 1 and 2.

completed. The chain is initiated when a patient has some risk for coronary artery disease conferred by multiple genetic and environmental factors. The patient seeks care, prompted by symptoms or the desire for preventive care. The physician evaluates the patient on the basis of symptoms and risk factors and may recommend a noninvasive study, such as an exercise stress test. The patient may or may not accept this recommendation and follow through with the test. In part on the basis of noninvasive test results, the physician then recommends that some patients undergo coronary angiography. Patients decide whether or not to follow this advice. When the primary physician is not a cardiologist, a cardiology consultation may be sought at any point.

**Relation between physician specialty and performance of coronary angiography.** This sequence suggests several potential explanations for the relation we found between having a cardiology regular source of care and performance of necessary coronary angiography. Cardiologists may have recommended angiography more often because they agreed with our multispecialty panel indications more than noncardiologists. Cardiologists may more frequently identify those patients meeting necessity criteria, or cardiologists may recommend the procedure more frequently for patients who need it but also for patients who do not. It is also possible that cardiologists may have been more effective in communicating their recommendations to undergo angiography to their patients or that patients of cardiologists may have been more receptive to aggressive diagnostic testing for heart disease. The effect of having a cardiologist as a regular source of care was larger in the public hospitals than in the private university hospitals, raising the possibility of interplay between specialty effects and system level factors. From the standpoint of undergoing necessary angiography, having regular cardiology care may be particularly important at public hospitals, where limited resources and administrative obstacles can make obtaining the procedure a special challenge.

**Study limitations.** Several limitations to this study should be noted. Our use of patient perceptions of their regular

**Table 5.** Independent Association Between Patient and Medical Care Characteristics and Use of Coronary Angiography

| Variable | Odds Ratio for Angiography Within 3 mo | 95% CI (p value) | Odds Ratio for Angiography Within 12 mo | 95% CI (p value) |
|---|---|---|---|---|
| Female gender | 0.5 | 0.3–0.99 (0.05) | 0.5 | 0.3–0.99 (0.05) |
| Stable angina or atypical chest pain (vs. no symptoms) | 1.8 | 0.8–3.8 (0.13) | 2.7 | 1.2–5.9 (0.01) |
| Unstable angina, prior MI or prior CABG (vs. no symptoms) | 4.7 | 1.8–12.0 (0.001) | 4.5 | 1.7–12.2 (0.003) |
| ≥2 cardiac risk factors | 1.1 | 0.6–2.0 (0.76) | 1.3 | 0.7–2.5 (0.39) |
| >2 yr at present home address | 1.7 | 0.7–4.0 (0.22) | 1.1 | 0.5–2.6 (0.79) |
| Public hospital | 0.4 | 0.2–0.8 (0.007) | 0.5 | 0.2–0.98 (0.04) |
| Cardiology regular source of care | 1.8 | 0.99–3.1 (0.05) | 3.6 | 2.0–6.6 (0.0001) |

Calculated by multiple logistic regression adjusting for age and ethnicity/race in addition to variables in table. Abbreviations as in Table 2.

source of care may have caused some bias in our results. However, determination of the regular source of care from the medical record in a population receiving care from multiple physicians is potentially invalid (19). Although it is true that patients who underwent angiography may have been more likely to misidentify a cardiologist as their regular source of care, the results were not substantially affected by a chart-based definition of specialty (i.e., the specialty of the physician ordering the treadmill test).

Nonresponse bias may have also affected the results. The interview sample differed from the total sample in two important respects: Hispanics and public hospital patients were underrepresented among survey respondents. If a large proportion of public hospital nonrespondents who did not undergo angiography had a cardiologist as a regular source of care, then we are overestimating the effect of having regular cardiology care and its interaction with hospital system. Similarly, we are underestimating the importance of nonadherence if nonrespondents were less likely to adhere to recommended care.

We were not able to determine whether patients who had a noncardiologist as a regular source of care received timely cardiology consultations after their abnormal treadmill test results and, if so, whether the consulting cardiologist (rather than the referring physician) was ultimately responsible for the decision to delay or withhold angiography. Future studies should examine whether ongoing continuity specialty care compared with episodic "consultative" care by a specialist affects use of clinically necessary procedures.

Coronary angiography is only one element of the care the patients in our sample needed. We did not assess whether other potentially important components of care that could affect clinical outcomes (e.g., use of antiischemic medications or management of comorbid conditions) differed by physician specialty. Further comparisons of noncardiologists and cardiologists should examine the process of care more broadly than our study allowed.

**Conclusions.** The present study cohort was more likely to undergo medically necessary coronary angiography when a cardiologist was the regular source of care. These differences were not explained by patient nonadherence. Having a cardiologist as a regular source of care was of somewhat greater importance within the public system than at the private university hospital, suggesting possible modification of physician specialty effects by system factors. These findings indicate the need for studies of how systems of care may modify specialty effects on the use of needed procedures. Further study of the relation between physician specialty and receipt of clinically necessary care in the rapidly expanding managed care sector that controls access to specialists is urgently needed.

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